



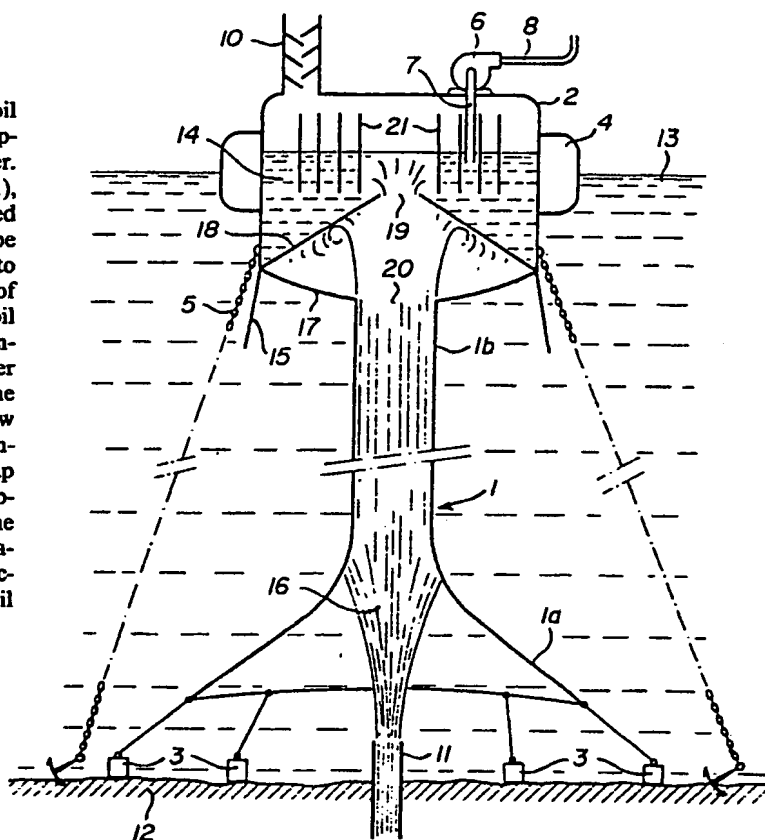
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(54) Title: EQUIPMENT FOR THE RECOVERY OF OIL FLOWING OUT OF SUB-WATER GROUND

(57) Abstract

Equipment for the recovery of oil flowing out of sub-water ground or escaping from the tanks of a wrecked oil tanker. The equipment comprises a tubular skirt (1), made of a flexible sheet material, composed of a flared lower part (1a) arranged to be placed around the oil flow and leading to an elongated upper part (1b) in the form of a hose of sufficient length to lead the oil flow near to the surface of the water. A container (2) is arranged to float on the water and be placed over the upper part of the hose to contain the oil flow (16) and allow removal of the oil. This equipment is simple, lightweight and comparatively cheap and is able to be very quickly put into operation and remain in service during all the duration of the repair operation of a damaged off-shore oil well or the total recovery of the oil contained in a wrecked oil tanker.



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EQUIPMENT FOR THE RECOVERY OF OIL FLOWING OUT OF SUB-WATER
GROUND

The present invention concerns an equipment for the recovery of oil flowing out of sub-water ground. More particularly, the invention concerns an equipment useful for recovery of oil escaping under high pressure from a damaged offshore oil well or for recovery of oil escaping from the damaged tanks of a wrecked oil tanker.

In case of blowout of offshore oil wells, liquid and gaseous hydrocarbons erupt under high pressure. The high pressure values make it very difficult if not impossible to directly attempt to shut-in operation of the damaged wellhead.

In order to stop the oil flow for allowing repair of the wellhead it is often necessary to proceed to drilling relief wells to intersect the blowout well in the pressurized formation and then to pump an adequate fluid through these relief wells so as to control the escaping pressure. However, drilling of the relief wells is a lengthy operation that may require months to be performed. During that time, oil continues flowing out freely into the sea which may cause severe damage to the marine and coastal environment. Recovery of oil leaking out of damaged tanks of a wrecked tanker raises similar difficulties although the problem of high pressure is usually not encountered in that case. An object of the invention is to allow complete recovery of the oil flow, using a very simple, lightweight and comparatively cheap equipment able to be very quickly put into operation and remain in service during all the duration of the repair operation of the damaged well or the total recovery of the oil contained in a wrecked oil tanker, while allowing without any restriction any repair work to be performed.

To that effect, the equipment according to the



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invention comprises a tubular skirt, made of a flexible sheet material substantially impervious to liquid and gaseous hydrocarbons, said skirt being composed of an elongated tubular part and a flared part forming an extension of the elongated part, the length of the skirt being sufficient for allowing the free end of the tubular part to come in the vicinity of the water surface when the skirt is placed over a location of the water bottom from which oil is flowing upwardly, the outer edge of the flared part of the skirt being held in the vicinity of the water bottom, so that oil will be collected by the flared part of the skirt and led up towards the water surface by the tubular part of the skirt acting as a hose, and means for collecting the oil and keeping it in a restricted area of the water surface, under the form of an oil layer having a sufficient thickness to allow the oil to be pumped out.

According to a preferred embodiment of the invention, the skirt is maintained in flattened and folded configuration, against the bottom of the water, with the lower edge of the flared part of the skirt tied to mooring means, around a wellhead in normal working conditions, in such a manner that the presence of the skirt does not interfere with the normal operation of the wellhead as well as with the usual survey and maintenance steps, appropriate means, comprising, for instance, inflatable or permanently inflated air bags being provided for releasing and quickly unfolding the skirt so that the free end of the tubular part is brought towards the surface of the water in case of occurrence or imminent risk of blowout or oil leakage.

In order that the invention may be more readily understood, an embodiment of the equipment will be described now, by way of example and with reference to the accompanying drawing, in which : Figure 1 is a lateral section of the equipment, illustrated in its working configuration over a damaged wellhead.



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Figure 2 is a schematical side elevation view of the lower part of the equipment, partly in section, illustrating its working configuration over a wrecked oil tanker.

Figure 3 is a schematical side elevation view of the lower part of the equipment, partly in section, showing on one hand the skirt in flattened and folded position, around a wellhead in normal operating condition, and, on the other hand, the skirt in one early stage of unfolding after it has been released in the case of blowout or oil leakage.

The equipment shown in figure 1 comprises a skirt 1 which is made of a flexible material, impervious to liquid and gaseous hydrocarbons and able to withstand the chemical action of oil and salt water, said material being, for instance, a sheet of polymeric plastic or elastomeric material or a waterproof cloth. The skirt 1 comprises a lower flared part 1a and an upper part 1b acting like a hose or a chimney. The outer edges of the lower part 1a of skirt 1 are maintained in their location, by appropriate moorings 3 such as concrete or cast-iron blocks, after the skirt has been placed over the damaged wellhead 11.

A bell-shaped container 2 is placed over the upper opening of the upper part 1b of skirt 1 and is kept floating on the water's surface 13 by floats 4. The container 2 is moored using chains 5 anchored on the water bottom 12. A skirt 15 continues the lower edge of container 2. Preferably, said skirt is made of a flexible material such as a sheet of polymeric plastic or elastomeric material or a waterproof cloth. If necessary, for example in the case when the equipment is to be used under bad sea conditions or with strong current, the skirt 15 may be provided with stiffening organs (not shown) such as gas or liquid inflatable tubings or chambers.

The relative location of the bell-shaped container 2 and the upper part 1b of skirt 1 is such that the opening



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of said upper part 1b is placed inside skirt 15. In the working configuration shown in the drawing, the upper part 1b of skirt 1 is tied to the container 2 by wires or chains 17, or other appropriate means thus ensuring that the upper end of part 1b is not displaced out of the interior of skirt 15 under the action of the waves or the currents or of the vibrations resulting from sudden changes of flow rate or pressure of the oil flow 16.

The oil flow 16, which is guided in the upper part 1b of skirt 1 is thus led into the inner part 9 of container 2 and forms an oil layer 14. The gaseous hydrocarbons are also held in the inner part 9 of container 2, above the oil layer 14. A pump 6 allows the liquid hydrocarbons of the oil layer 14 to be pumped out through at least one channel 7 with or without pump attached and to be transported through channel 8 into appropriate containers, for instance in a tanker, for storage and transport. The gaseous hydrocarbons are separated from any liquid fractions which may be mixed with the gas, in an appropriate chamber 10 provided with baffle-plates and then led to storage and transport gas container or to burning means (not shown).

A deflecting wall 18, having the form of an inverted funnel with an upper central aperture 19, is preferably provided at the bottom of container 2, above the aperture 20 of the tubular upper part 1b of skirt 1, in order to limit the turbulence of the oil and gas flow entering into container 2. Instead of just one central aperture 19, deflecting wall 18 may also be provided with a plurality of apertures, if convenient.

Baffle plates or walls 21, placed for instance, vertically, may also be provided if necessary with the same purpose of limiting the turbulence of the liquid and gas contained in container 2.

As shown in figure 2, the lower flared part 1a of



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the skirt 1 can be made of sufficiently large size to be placed over and entirely cover a wrecked oil tanker 22 thus allowing collection of the flow of oil 23 escaping from the damaged tanks of the tanker.

In the position shown in full line in figure 3, the skirt 1 is placed in flattened and folded condition against the bottom 12 of the water, around a normal operating wellhead 24 with riser 25 and command and control lines 26 normally connected.

The lower edge of flared part 1a of skirt 1 are tied to mooring means 3, the folded and flattened tubular part 1a being maintained against water bottom 12 by appropriate securing means (not shown) which may be automatically or manually operated to release the part 1a in case of blowout or other cause or oil leakage.

Bags 27, which may be inflated (as shown) or are inflatable, with air or an inert gas such as nitrogen, are tied to the edge of the free end of tubular part 1a of skirt 1.

The position shown in phantom in figure 3, corresponds to an early stage of unfolding of the skirt 1 after release of tubular part 1a. In the fully unfolded position, skirt 1 assumes the operating configuration shown in figure 1.

It is thus clear that, owing to the fact that the skirt can be maintained around the wellhead during normal operation and nearly instantly put into the oil recovery position in case of necessity, the equipment according to the invention provides a very efficient way of avoiding oil spilling in case of blowout of offshore oil wells.

It will be clear that the shape, dimensions and relative proportions of the different part of the equipment can be adapted to the needs, particularly according to the water depth, oil pressure and flow rate, relative proportion of gaseous and liquid hydrocarbons, etc... On the other hand,



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it is to be noted that the edges of the flared lower part 1a of skirt 1 can be suitably positioned, with respect to the water bottom 12, and/or of appropriate shape or, else, be provided with suitable openings or gates so as to allow an easy access to the damaged wellhead 11, for survey or repair purpose, by divers or unmanned or manned submersible.

It is to be noted that the lower edge of the flared part 1a of skirt 1 need not, and will generally not, be placed in the immediate vicinity of the water bottom 12 and that in practice, the distance between said edge and the bottom will be amply sufficient for allowing easy access to the damaged wellhead 11 and, in any case, instant and permanent equalization of the pressure of the mass of oil gas water contained under or inside skirt 1 with the pressure of the water outside skirt 1, even in case of strong and sudden surges of pressure of the oil and gas column escaping from wellhead 11.

Owing to this possibility of instant pressure equalization, there is no risk of damages to be caused to the skirt, even if the pressure of the oil and gas column is high and subject to sudden variations.

If necessary, in particular in the case when the equipment is to be used in cold water, the wall of skirt 1, more particularly those of its upper part 1b, can advantageously be provided with a heat insulating sheath or lining. A heating fluid may also be circulated in chambers or channels located in contact of the skirt walls or between these walls and the said lining. Thus, formation of a viscous cold layer of hydrocarbons sticking on the inner wall of the skirt 1 can be avoided.

From the above description, it clearly appears that the basic principle of the equipment according to the invention is simple and that this equipment can be realized under a sturdy form with low manufacturing and maintenance costs. The equipment can be put in operation in a particularly simple



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and speedy manner and its handling and control are free of any risk. Namely, apart the above-mentioned case when the skirt is maintained in folded configuration around a wellhead in normal working condition, and is thus able to be almost instantly put into operating configuration, the equipment can be put in operation by simply towing the skirt 1 underwater over the damaged wellhead 11 or the wrecked tanker 22 and then mooring it in its working location as shown in the drawings. Finally, the bell-shaped container 2 is moored in the appropriate location with respect to the upper part 1a of skirt 1, for instance as shown in the drawings.



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CLAIMS

1. Equipment for the recovery of oil flowing out of sub-water ground, comprising a tubular skirt, made of a flexible sheet material substantially impervious to liquid and gaseous hydrocarbons, said skirt being composed of an elongated tubular part and a flared part forming an extension of the elongated part, the length of the skirt being sufficient for allowing the free end of the tubular part to come in the vicinity of the water surface when the skirt is placed over a location of the water bottom from which oil is flowing upwardly, the outer edge of the flared part of the skirt being held in the vicinity of the water bottom, so that oil will be collected by the flared part of the skirt and led up towards the water surface by the tubular part of the skirt acting as a hose, and means for collecting the oil and keeping it in a restricted area of the water surface, under the form of an oil layer having a sufficient thickness to allow the oil to be pumped out.

2, Equipment according to claim 1, wherein said oil collecting means comprise a bell-shaped container kept floating on the water surface above the free end of the tubular part of said skirt with a part of its lateral wall being immersed in water to a depth at least equal to the thickness of the collected oil layer.

3. Equipment according to claim 2, wherein the lower edge of said bell-shaped container is extended by a skirt made of a flexible material.

4. Equipment according to claim 2, wherein a deflecting wall, having the form of an inverted funnel, with at least one aperture, is provided at the bottom of said bell-shaped container.



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5. Equipment according to claim 2, wherein said bell-shaped container is provided with baffle plates for limiting the turbulence of the liquid and gas contained therein.

6. Equipment according to claim 1, wherein said skirt is maintained in flattened and folded configuration, around a wellhead in normal operating condition, in such a manner that the skirt is able to be released and quickly unfolded so that the free end of its tubular part is brought towards the water surface in case of occurrence or imminent risk of blowout or oil leakage.



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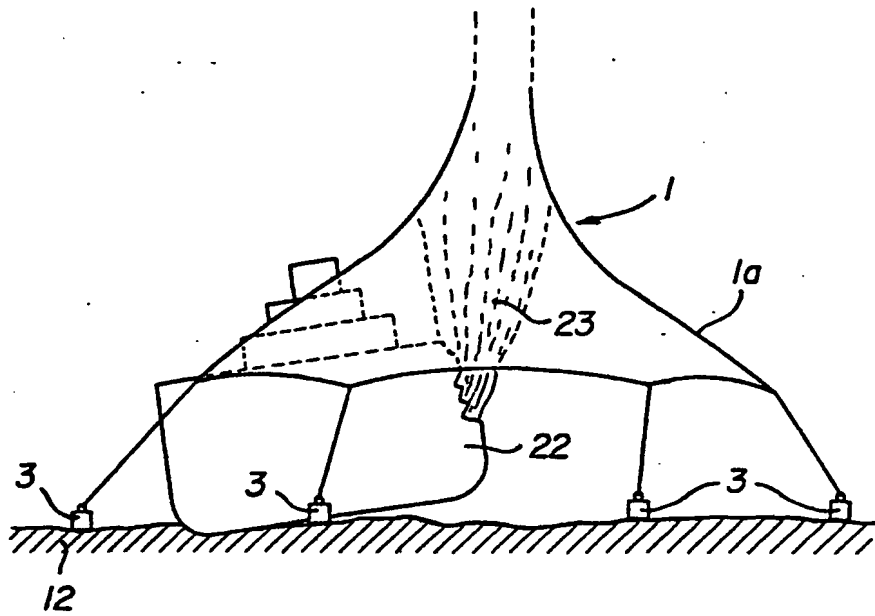


FIG. 2

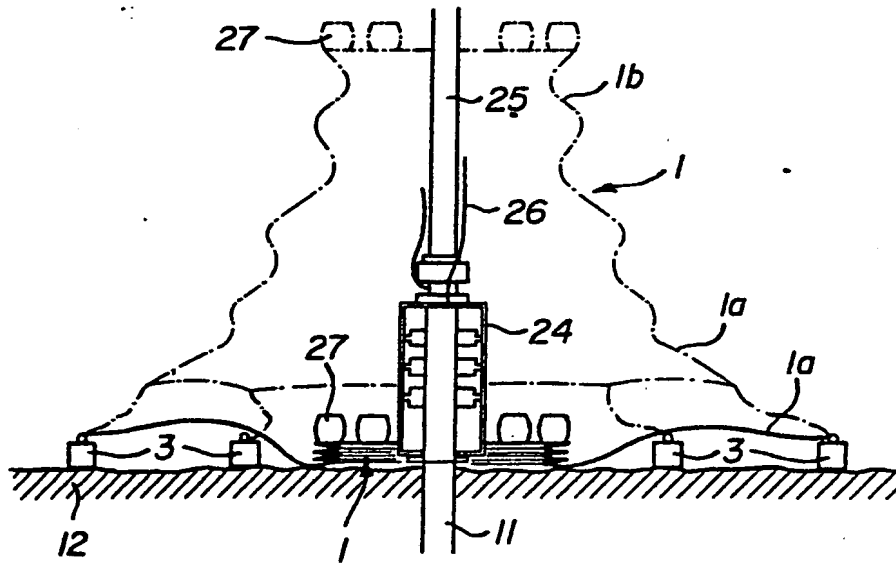


FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 81/00166

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ³ According to International Patent Classification (IPC) or to both National Classification and IPC IPC ³ : E 02 B 15/04; E 21 B 43/01																				
II. FIELDS SEARCHED <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Minimum Documentation Searched ⁴</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 20%; text-align: left; border-bottom: 1px solid black;">Classification System</th> <th style="text-align: left; border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">IPC³</td> <td style="border: 1px solid black; padding: 5px;">E 02 B; E 21 B; B 63 C</td> </tr> </table> <div style="border-top: 1px solid black; padding-top: 5px;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁵</div>			Classification System	Classification Symbols	IPC ³	E 02 B; E 21 B; B 63 C														
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III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; text-align: left; padding: 5px;">Category [*]</th> <th style="text-align: left; padding: 5px;">Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷</th> <th style="width: 10%; text-align: left; padding: 5px;">Relevant to Claim No. ¹⁸</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">X</td> <td style="padding: 5px;">US, A, 3548605 (PAULL) 22 December 1970 see column 2, line 53 - column 3, line 17; column 3, line 46 - column 6, line 35 ---</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1,6</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">US, A, 2132800 (PAYTON) 11 October 1938 see page 1, column 1, line 49 - page 2, column 1, line 17 ---</td> <td style="text-align: center; vertical-align: top; padding: 5px;">2-4</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">US, A, 3674150 (LEJEUNE) 4 July 1972 see column 1, line 56 - column 3, line 40 ---</td> <td style="text-align: center; vertical-align: top; padding: 5px;">2,4</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">FR, A, 2368581 (KERUZORE) 19 May 1978 ---</td> <td></td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">P,X</td> <td style="padding: 5px;">GB, A, 2063777 (CESSOU) 10 June 1981 see page 2, line 5 - page 3, line 24 -----</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-5</td> </tr> </tbody> </table>			Category [*]	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸	X	US, A, 3548605 (PAULL) 22 December 1970 see column 2, line 53 - column 3, line 17; column 3, line 46 - column 6, line 35 ---	1,6	A	US, A, 2132800 (PAYTON) 11 October 1938 see page 1, column 1, line 49 - page 2, column 1, line 17 ---	2-4	A	US, A, 3674150 (LEJEUNE) 4 July 1972 see column 1, line 56 - column 3, line 40 ---	2,4	A	FR, A, 2368581 (KERUZORE) 19 May 1978 ---		P,X	GB, A, 2063777 (CESSOU) 10 June 1981 see page 2, line 5 - page 3, line 24 -----	1-5
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<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>[*] Special categories of cited documents: ¹⁵</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p> </div> </div>																				
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